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ABSTRACT

This study investigated liberal arts college students' preferences for various teaching methods and testing techniques in relation to their measured cognitive style. A total of 100 students completed the Gregorc Style Delineator and a questionnaire on instructional methods commonly used in college classes. The results indicated that the sequential-random dimension of Gregorc's model was the stronger predictor of learning style. High sequential scorers preferred teaching methods such as structured lecture and independent lab experiments, and tests comprised of problems with concrete answers. These students tended to be science majors rather than social science or humanities majors. High random scorers preferred group discussion and group projects, and assessment by projects or class discussion. These students tended to be humanities majors. It is concluded that Gregorc's cognitive styles appear to be related to the instructional preference of liberal arts college students. (Contains 10 references.) (Author/MDM)

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Gregorc's Cognitive Styles: Preferences for Instructional and Assessment Techniques in College Students

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Poster Presented at the 1997 Annual Convention of the American Psychological Society

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Abstract

This study investigated liberal arts college students' preferences for various teaching methods and testing techniques in relation to their measured cognitive style. One hundred students completed the Gregorc Style Delineator and a questionnaire comprised of instructional methods commonly used in college classes. Results indicate that the sequential-random dimension of Gregorc's model is the stronger predictor of learning style. High sequential scorers prefer teaching methods such as structured lecture and independent lab experiments, and tests comprised of problems with concrete answers. These students tend to be Science majors. High random scorers prefer group discussion and group projects, and assessment by projects or class discussion. These students tend to be Humanities majors. With qualifications, Gregorc's cognitive styles appear related to instructional preferences of liberal arts college students.

Gregorc's Cognitive Styles: Preferences for Instructional and Assessment Techniques in College Students

Educational leaders and researchers have been focusing on the concept of cognitive learning styles in schools and colleges for decades. Cognitive learning styles can be defined as "information processing habits representing the learner's typical mode of perceiving, thinking, problem solving, and remembering" (Messick, 1970, p.188 as cited by O'Brien, 1994). Before 1940, research on learning styles was mostly concerned with the relationship between oral or visual teaching methods and memory. Since the 1960s, however, the consideration of learning style has expanded to include selection strategies, open/closed mindedness, memory or retention styles, risk taking versus cautiousness, and sensory modality preferences. One current approach to learning styles is offered by Anthony Gregorc, who focuses on mental qualities (Kaplan & Kies, 1993).

Gregorc describes the cognitive abilities of perception and ordering. "Perception, 'the means through which you grasp information' (Gregorc, 1982b, p.5 as cited by O'Brien, 1991), is represented as a bipolar continuum ranging from abstractness to concreteness" (p.493). Abstractness is the mental quality which leads to apprehension of intangible information through the use of reason, emotion, and intuition. Concreteness is the mental quality whereby one apprehends tangible information through use of the physical senses. "Ordering, 'the ways in which you

authoritatively arrange, systematize, reference, and dispose of information' (Gregorc, 1982b, p.5 as cited by O'Brien, 1991) is represented by a bipolar continuum ranging from sequence to randomness" (p. 493). The sequential quality entails linear, methodical, and systematic processing of information with discrete categorization of stored data. Randomness entails nonlinear, unstructured, simultaneous, and holistic processing of information with broad categorization of memory representations (O'Brien, 1991).

Gregorc's Cognitive Styles Model

Gregorc (1979) suggests that while everyone possesses some ability in each of the four dimensions, most people tend to exhibit a preference for, or orientation toward, one or the other end of the perception and ordering continuums. Using a quaternary design, Gregorc combines the perception and ordering qualities to form four, in his terms, mediation channels: Concrete Sequential (CS), Concrete Random (CR), Abstract Sequential (AS), and Abstract Random (AR). Gregorc asserts that roughly 90 percent of individuals have a natural predisposition toward one or two of these channels and that they serve to mediate how individuals learn from and act upon their environment (Gregorc & Butler, 1984).

It has been argued that the Concrete Sequential (CS) learner appreciates order and logical sequence, likes touchable, concrete materials, prefers step-by-step directions, looks for and

follows instructions, and likes clearly ordered presentations and a quiet atmosphere. The CS learner also reportedly prefers the teaching styles of workbooks, manuals, lecturing, hands-on material, and multiple-choice tests (Gregorc & Butler, 1984; Kaplan & Kies, 1993). The Concrete Random (CR) learner has been reported to use trial and error to acquire information, dislikes cut-and-dry procedures, does not respond well to teacher intervention, works well alone or in small groups, and prefers the teaching methods of games, simulations, independent study projects, optional reading, group projects, and short answer quizzes (Gregorc & Butler, 1984; Kaplan & Kies, 1993). The Abstract Sequential (AS) learner is described as having excellent writing, verbal, and image decoding abilities, is able to extract main ideas from a logical presentation, possesses and prefers to use reading and visual translation skills, and prefers the teaching methods of extensive reading assignments, substantive lectures, audio tapes, and analytic think sessions (Gregorc & Butler, 1984; Kaplan & Kies, 1993). Finally, the Abstract Random (AR) learner pays close attention to human behavior, is attuned to atmosphere and mood, ties in the speaker's manner, delivery, and personality to the message, evaluates learning holistically, prefers multi-sensory experiences, and prefers the teaching methods of movies, group discussions, short lectures with questions/answers and discussion, and multi-media (Gregorc & Butler, 1984; Kaplan & Kies, 1993).

Research on Styles

The Gregorc Style Delineator (GSD) (1982a) is a self-report inventory designed to measure the four cognitive styles or learning patterns. According to Gregorc (1982a), the instrument is intended for self-analysis and can help reveal to individuals the mental qualities or "mediation channels" available to them for handling life demands. The GSD and its predecessor, the Transaction Ability Inventory (Gregorc, 1978) have attracted much attention and study. At least 45 dissertations written between 1980 and 1991 were based on the GSD or used the instrument for data collection (Ferro, 1995).

Several studies using the GSD have investigated gender differences in regard to cognitive style preferences, with varying results. One common finding is that males tend to score higher than females on the Abstract Sequential style (Davenport, 1986; O'Brien, 1991). Another common finding is that females tend to score higher than males on the Abstract Random style (Davenport, 1986; O'Brien, 1991; O'Brien, 1994). Research on field of study has shown preference according to cognitive style (O'Brien, 1991), but this research was not conducted at a liberal arts college.

Purpose of the Study

The present study was designed to validate Gregorc's theoretical cognitive styles on a population of liberal arts college students. The primary purpose of the study, however, was to empirically test the relationship between Gregorc's cognitive

styles and the purported preferences for instructional and assessment techniques. Since cognitive style has been related to choice of major, this study also investigated choice of major in a liberal arts college. Based on the work of O'Brien (1991), it was predicted that Humanities majors would score higher on the Abstract Random subscale whereas Science majors would score higher on the Concrete Sequential subscale. Gender was examined for the purpose of replicating previous research findings.

Method

Phase 1: Pretesting Preferences for Instructional and Assessment Techniques

Materials were developed to assess preferences for instructional and assessment techniques. A list of teaching methods and a list of testing techniques was devised. Both lists were comprised of the methods proposed by Gregorc as well as others that are commonly used in college classes.

Ten students from a psychology course pretested the instructional materials. In order to accommodate differences in learning style, a variety of items that would indicate such differences were tested. Participants rated instructional items on a 5-point likert scale, where a "1" indicated their poorest learning under such a teaching method and a "5" indicated their best learning. Scores for each item were examined individually, and those for which the range of student responses differed by

four points, or by three points if the three points included an extreme of the scale, were retained for the final questionnaire. These items were deemed to have the greatest potential for discriminating students' learning preferences. Items retained for the study are included in Table 3.

Twelve additional students rated the assessment items on a 5-point likert scale, where a "1" indicated their worst performance under such a testing method and a "5" indicated their best performance. Again, we were interested in a variety of items that would discriminate differences according to preferred learning style. Items for which the range of student responses differed by 4 points, or by 3 points if the 3 points included the extreme of the scale, were selected for the final questionnaire. Items retained for the study are included in Table 5.

Phase 2: Administration of the Gregorc Style Delineator and Instructional and Assessment Questionnaires

Participants

The study was conducted at a small, private liberal arts undergraduate college in the northeastern region of the United States. One hundred full-time students were selected with the goal of roughly balancing major area of study and gender. The sample consisted of 48 males and 52 females. Thirty-five of the students were natural science majors (i.e., biology, chemistry, physics, computer science, or mathematics), 35 were social science majors (i.e., anthropology, sociology, psychology, economics,

politics, communication arts, or international relations), and 30 were humanities majors (i.e., history, philosophy & religion, English, or Classics).

Instrumentation

The Gregorc Style Delineator (Gregorc, 1982a) was used to assess participants' learning style. Respondents rank order 4 words within each of 10 column sets by assigning the numbers "1" (least descriptive of self) to "4" (most descriptive of self). Ranks assigned to the 10 words that characterize each learning style (CS, AS, AR, CR) are then summed across the 10 columns to yield 4 subscale scores. Scoring instructions (Gregorc, 1982a) indicate that for any given subscale, a score of 27-40 is considered high, 16-26 is intermediate, and 10-15 is low.

Gregorc (1982b) reports the reliability and validity of the instrument. One hundred and ten adults tested from 6 hours to 8 weeks apart achieved standardized alphas ranging from .89 (AS) to .93 (AR) for 6 hours apart and .91 (CR) to .92 (CS,AS,AR) for 8 weeks apart. While some researchers report substantially lower alpha coefficients (Joniak & Isaksen, 1988, as cited by Benton, 1995), O'Brien (1990, as cited by O'Brien, 1994) reports acceptable alpha coefficients ranging from .51 to .64. Further, although a confirmatory factor analysis suggested that all items were not functioning equally effectively, jointly they provide adequate subscales supporting the four style constructs (O'Brien, 1994). The reliability of the Gregorc Style Delineator is

sufficient to investigate the construct validity in terms of its use in the classroom.

Preferences for instructional methods were measured by a Teaching Methods Scale comprised of the 13 items from the pretest. Each item was followed by a 5-point likert scale, with a "1" indicating poorest learning by such a method and a "5" indicating best learning. Preferences for assessment techniques were measured by a Testing Techniques Scale comprised of 11 items from the pretest. Items were rated on a 5-point likert scale, with a "1" indicating worst performance by such a technique and a "5" indicating best performance. A separate page was used to collect demographic information on gender and major area of study. The entire questionnaire packet, in order of appearance, consisted of the Gregorc Style Delineator and its instructions, the demographic information sheet, the Teaching Methods Scale, and the Testing Techniques Scale.

Procedure

Student participants were individually selected by the primary researcher from a variety of campus residence locations including dormitories and suites. The researcher selected rooms at each location and individually administered the Gregorc Style Delineator and the self-report questionnaire to available students. No return visit was made to rooms in which no students were present. All inventories and questionnaires were labelled with matching numbers so that the identity of participants would

remain anonymous. The researcher kept a running log tallying gender and major area of study in order to approximate a stratified sample for these variables. As data collection progressed, only students who met the remaining needed qualifications were asked to follow through with the study.

Results

Each inventory was hand-scored by the primary researcher. The highest possible score on each subscale (CS, AS, AR, CR) is 40, with a score of 27 or above considered a high score, as suggested by Gregorc (1982a). Scores on the four cognitive scales were used to create categories of high scorers for each style. Students with high scores in more than one learning style were considered to have a dual learning style preference. Table 1 shows the percentage of participants for each learning style.

The majority of the college students in this sample were high scorers in more than one of Gregorc's styles. Only 41% of the students were high scorers in a single learning style: 15% were Concrete Sequential (CS), 13% were Abstract Random (AR), and the balances of 13% were distributed between Concrete Random (CR) and Abstract Sequential (AS). Gregorc (1982c, as cited by O'Brien, 1994) suggested that the most common cognitive style is Concrete Sequential (CS), followed by Abstract Sequential (AS) and Abstract Random (AR), with only a small percent of the population scoring as Concrete Random (CR). With qualifications, students of this study tended to fit the pattern described. Forty-eight percent of

the students had high scores on the CS scale, either as a single preferred style or in combination with another style. Similarly, 41% of the students were high scorers on the AR scale either alone or in addition to another scale. Although only 4% scored high on solely the AS scale, an additional 27% had high AS scores in addition to a high score on another scale. The same was true for the CR scale, with only 9% scoring high solely on this scale, yet an additional 31% scoring high on the CR scale as well as on another.

While the O'Brien (1994) data indicated a breakdown of scorers along the concrete-abstract dimension, data analysis in this study revealed that the sequential-random dimension was the stronger predictor of student learning style preferences. Eighteen percent of the students were high scorers on the Concrete Sequential and Abstract Sequential (Dual Sequential) combination, and another 18% were high scorers on the Concrete Random and Abstract Random (Dual Random) combination. Thus, the four predominant styles in this study, accounting for 64% of the population, were CS, AR, CS & AS, and CR & AR.

Intercorrelations were performed on responses to the Teaching Methods Scale items. Items which had positive, significant correlations with one another were deemed related, and their mean responses were averaged to create a single teaching method category. If two items were significantly correlated with a third item but not with each other, the items were not combined. Items

which did not fit into a larger category were left to stand alone for subsequent data analysis. This procedure resulted in nine teaching method distinctions. Study guide workbooks, structured lecture, homework problems, and ditto sheets were combined into the category "structured activities." Writing assignments and independent study projects were combined into the category "independent thought assignments." Audio tapes, group discussion, unstructured lecture, short lecture followed by questions/answers and discussion, group projects, independent lab experiments, and group lab experiments each remained as individual items.

Ratings on resultant teaching methods served as dependent variables for a 9 x 4 x 2 (Teaching Method x Cognitive Style x Gender) MANOVA. Teaching method was a within-subjects variable while cognitive style and gender were between-subjects variables. Only the four predominant styles were used in this analysis. The 3-way interaction of cognitive style by gender by teaching method was not significant (see Table 2). The interaction of cognitive style and teaching method was significant, $F(24,416) = 2.92$, $p < .001$. The interaction of gender and teaching method was also significant, $F(8,416) = 2.12$, $p = .003$.

Simple effects were probed using oneway ANOVAs. These were conducted on each level of teaching method by cognitive style to determine on which items students of the four predominant learning styles differed. Post hoc analyses using Tukey's multiple range test were conducted where appropriate. Table 3 shows the mean

scores on teaching methods by students within the four predominant style categories. There were significant differences between learning styles for four of the teaching methods. Dual Sequential learners preferred the structured activities more than the Dual Random learners, $F(3,57) = 3.33$, $p = .03$. Dual Sequentials and Concrete Sequentials preferred independent lab experiments more than the Dual Randoms, $F(3,60) = 4.46$, $p = .007$. Dual Random learners preferred group discussion more than Dual Sequential and Concrete Sequential learners, while Abstract Random learners also preferred group discussion more than Dual Sequentials, $F(3,60) = 7.63$, $p = .0002$. Dual Random learners preferred group projects more than Dual Sequentials, $F(3,60) = 2.73$, $p = .05$.

Oneway ANOVAs were also conducted on each teaching method by gender, however the analyses revealed no significant gender differences.

Intercorrelations were performed on responses to the Testing Techniques Scale items. Items which had positive, significant correlations with one another were deemed related and their mean responses were averaged to create a single testing method category. If two items were significantly correlated with a third item but not with each other, the items were not combined. Items which did not fit into a larger category were left to stand alone for subsequent data analysis. This procedure resulted in eight testing technique distinctions. Word problems and problems with concrete answers were combined into the category "structured

problem-solving." Performances or projects, oral presentations, and classroom discussions were combined into the category "independent originations." Multiple-choice tests, matching tests, short answer tests, fill-in-the-blank tests, essay tests, and problems with multiple solutions each remained as individual items.

The resultant testing techniques served as dependent variables for an 8 x 4 x 2 (Testing Technique x Cognitive Style x Gender) MANOVA. Testing technique was a within-subjects variable while cognitive style and gender were between-subjects variables. Only the four predominant styles were used in this analysis. The 3-way interaction of cognitive style, gender, and testing technique and the 2-way interaction of gender and testing technique were not significant (see Table 4). The interaction of cognitive style and gender was significant, $F(3,54) = 4.53$, $p = .007$. However, this finding is uninterpretable since it collapsed over testing techniques. The interaction between cognitive style and testing technique was significant, $F(21,378) = 2.29$, $p = .001$.

Oneway ANOVAs were then conducted on each testing technique by cognitive style to determine on which items students of the four predominant learning styles differed. Post hoc analyses using Tukey's multiple range test were conducted where appropriate. Table 5 shows the mean scores on testing techniques by students within the four predominant style categories. There were significant differences between the learning styles for two

of the testing techniques. Dual Sequential and Concrete Sequential learners preferred structured problem-solving more than Dual Random learners, $F(3,60) = 5.77$, $p = .002$. Dual Random learners preferred independent originations more than Dual Sequential, Concrete Sequential, and Abstract Random learners, $F(3,59) = 7.30$, $p = .0003$.

Gender and choice of major were investigated in relation to the four predominant styles of this study (CS, Dual Sequential, AR, Dual Random) using crosstabulations followed by Chi Square analysis. No significant gender effects emerged using this method of analysis.

Major was categorized as Science (biology, chemistry, physics, computer science, mathematics), Social Science (anthropology, psychology, sociology, economics, communication arts, international relations), and Humanities (history, philosophy & religion, English, Classics). The Chi Square analysis of major by cognitive style was significant, $^2(6) = 28.45$, $p = .0001$ (see Table 6). Science majors tended to be high Concrete Sequential and Dual Sequential scorers. Humanities majors scored predominantly in the Dual Random style. Social Science majors were distributed relatively evenly across the cognitive styles.

Discussion

Cognitive Style Patterns

The four dominant categories which emerged in this study were

the single styles of Concrete Sequential (CS) and Abstract Random (AR), and the dual styles which are distinguished by the sequential-random dimension, CS & AS and CR & AR. Sixty-four percent of participants had high scores within these four categories. Consistent with Gregorc's (1982a; Gregorc & Butler, 1984) assertion that most people are naturally predisposed to function in one or two mediation channels, ninety-nine percent of the students had high scores in one or two of Gregorc's styles.

The sequential-random dimension appears to play a stronger role than the concrete-abstract dimension in discriminating learning preferences. The results of this study indicate that most dual-style scorers fall as either dual-sequentials or dual-randoms, and that these students differ significantly in their preference for several teaching and testing activities.

It must also be noted that while other researchers have found gender differences in relation to learning style (Davenport, 1986; O'Brien, 1991; O'Brien, 1994), this study found no such differences.

Style and Classroom Learning

Finding that Gregorc's styles discriminate among students with some modification to the style categories, the next issue to address is whether the styles are predictive of preferences for particular kinds of classroom teaching and testing activities.

Gregorc (1979) proposed that both Concrete Sequential (CS) and Abstract Sequential (AS) learners appreciate presentations

which have substance, and which are rational, orderly, and sequential in nature. Consistent with Gregorc's conception, Dual Sequential (CS & AS) scorers of this study prefer to learn by structured teaching methods such as dittos, workbooks, assigned homework problems, and organized lectures. These students also prefer to be assessed by structured testing techniques such as working through mathematical or word problems resulting in concrete answers. It is not surprising then, that the Concrete Sequential and Dual Sequential learners tend to major in the Sciences, where classroom activities are geared toward hands-on, structured performance.

Gregorc (1979) also suggested that Concrete Random (CR) and Abstract Random (AR) learners are alike in their preference for receiving and working with information independently and in an unstructured manner. Supporting this description, Dual Random (CR & AR) scorers of this study prefer to learn by participation in group discussion and group projects, activities which allow for independent thought and self-direction. These students also prefer to be assessed by activities allowing for independent creativity such as performances, projects, and oral presentations. In keeping with their preferences for unstructured learning, Dual Random learners tend to major in the Humanities, and Abstract Random learners generally choose majors in the Social Sciences or Humanities. Courses within these majors tend to provide more opportunity for unstructured learning through discussion sessions

and through independently conceived projects and writing topics.

General Summary

This study demonstrated that the Gregorc Style Delineator, specifically with its sequential-random aspect of measurement, does discriminate learning preferences of students at a liberal arts college. Students scoring high on the sequential styles tend to prefer structured activities while students scoring high on the random styles tend to prefer activities involving freedom of design and expression.

One must keep in mind, however, that the teaching and testing techniques for which this sample of college students had greater preferences were those commonly used in their classes. The items in the pretest which were generally rated lower than other items were those with which liberal arts college students had less experience and familiarity. Some examples include television, movies, slides, and games or simulations. Certainly, people can and do learn by these activities, but they are generally used less often in the college classroom where time is limited and lecture is emphasized. Thus, students who could learn better by these or other unnamed methods do not have the opportunity to develop associated skills which could enhance their academic success. Innovative methods can, and should, be employed to give students the opportunity to discover how their learning is facilitated.

Gregorc's conception of learning styles is helpful in determining which students might perform better under specific

teaching methods, but administering a cognitive scale certainly is not necessary to be an effective teacher. Most classrooms will have students with a variety of learning style preferences. Effective teaching entails a general awareness that individual differences exist in the classroom. Eclecticism is thus the key to reaching all students, and in order to maximize all students' potential for academic success, a variety of instructional and assessment methods must be employed. While not every activity will be preferred by each student, variety is still important in developing skills characteristic of students' nonpreferred styles of learning. Outside of the classroom there are both structured and unstructured environments in which people must constantly be engaged. Both sequential and Random learners would benefit from exposure to all types of instructional situations. While traditional teaching methods may be successful promoters of student learning, innovation which uses other educational tools must not be overlooked.

References

Benton, S.L. (1995). Review of the Gregorc style delineator. The Twelfth Mental Measurements Yearbook. Ed. Jane Close Conoley and James C. Impara. Lincoln, Nebraska: University of Nebraska Press. 426-427.

Davenport, J.A. (1986). Learning style and its relationship to gender and age among elderhostel participants. Educational Gerontology, 12, 205-217.

Ferro, T.R. (1995). Review of the Gregorc style delineator. The Twelfth Mental Measurements Yearbook. Ed. Jane Close Conoley and James C. Impara. Lincoln, Nebraska: University of Nebraska Press. 427-428.

Gregorc, A.F. (1979). Learning/teaching styles: their nature and effects. In Student Learning Styles: Diagnosing and Prescribing Programs. Reston, VA: National Association of Secondary School Principals. 19-26.

Gregorc, A.F. (1982a). Gregorc style delineator. Maynard, MA: Gabriel Systems, Inc.

Gregorc, A.F. (1982b). Gregorc style delineator: Development, technical, and administration manual. Maynard, MA : Gabriel Systems, Inc.

Gregorc, A.F. & Butler, K.A. (1984). Learning is a matter of style. VocEd, 59(3), 27-29.

Kaplan, E.J. & Kies, D.S. (1993). Together: teaching styles and learning styles improving college instruction. College Student Journal, 27, 509-513.

O'Brien, T.P. (1991). Relationships among selected characteristics of college students and cognitive style preferences. College Student Journal, 25, 492-500.

O'Brien, T.P. (1994). Cognitive learning style and academic achievement in secondary education. Journal of Research and Development in Education, 28, 11-21.

Table 1

Percentage of High Scorers by Learning Style Category

Style	Percentage of Participants
Concrete Sequential (CS)	15
Abstract Sequential (AS)	4
Abstract Random (AR)	13
Concrete Random (CR)	9
CS & AS	18
CS & AR	8
CS & CR	6
AS & AR	2
AS & CR	6
AR & CR	18
AS & CS & CR	1

Note. N = 100.

Table 2

Multivariate Analysis of Variance for Teaching Methods

Source	df	F
	Between subjects	
Cognitive Style (C)	3	0.29
Gender (G)	1	2.85
C x G	3	1.97
S within-group error	52	(1.45)
	Within subjects	
Teaching Method (T)	8	21.08**
T x C	24	2.92**
T x G	8	2.12*
T x C x G	24	1.22
T x S within-group error	416	(0.92)

Note. Values enclosed in parentheses represent mean square errors. S = subjects.

*p < .05. **p < .001.

Table 3

Preference Scores of Teaching Methods by Cognitive Style

Teaching Method	Cognitive Style: Concrete Sequential	Dual Sequential	Abstract Random	Dual Random
Structured Activities[a]				
M	3.65	4.01[1]	3.62	3.23[1]
SD	0.55	0.48	0.85	0.90
n	15	17	13	16
Independent Lab Experiments				
M	3.07[1]	3.33[2]	2.46	2.00[12]
SD	1.39	1.28	0.78	1.38
n	15	18	13	18
Group Discussion				
M	3.47[3]	3.22[12]	4.15[2]	4.56[13]
SD	1.06	1.11	0.69	0.70
n	15	18	13	18
Group Projects				
M	3.07	2.56[1]	3.31	3.56[1]
SD	0.96	1.15	1.11	1.10
n	15	18	13	18

(table continues)

Teaching Method	Cognitive Style: Concrete Sequential	Dual Random	Abstract Random	Dual Random
Independent Thought Assignts.				
M	3.37	3.61	3.42	3.56
SD	0.86	0.70	0.64	0.95
n	15	18	13	18
Audio Tapes				
M	2.00	2.29	2.23	2.18
SD	1.00	0.92	0.93	0.88
n	15	17	13	17
Unstructured Lecture				
M	2.33	2.11	2.23	2.72
SD	1.18	1.02	1.09	1.45
n	15	18	13	18
Short Lecture w/ Q/A and Discussion				
M	3.53	3.56	4.00	3.56
SD	0.83	1.25	0.71	1.04
n	15	18	13	18

(table continues)

Teaching Method	Cognitive Style: Concrete Sequential	Dual Sequential	Abstract Random	Dual Random
Group Lab Expts.				
M	3.07	3.11	2.85	2.83
SD	1.22	1.32	1.07	1.25
n	15	18	13	18

Note. Matching superscripts indicate means which are significantly different at the $p < .05$ level within each teaching method row.

[a]Structured Activities includes study guide workbooks, structured lecture, homework problems, and ditto sheets.

[b]Independent Thought Assignments includes writing assignments and independent study projects.

Table 4

Multivariate Analysis of Variance for Testing Techniques

Source	df	F
	Between subjects	
Cognitive Style (C)	3	0.60
Gender (G)	1	1.65
C x G	3	4.53*
S within-group error	54	(1.15)
	Within subjects	
Testing Technique (T)	7	5.98**
T x C	21	2.29**
T x G	7	1.07
T x C x G	21	0.52
T x S within-group error	378	(0.98)

Note. Values enclosed in parentheses represent mean square errors. S =subjects.

*p < .01. **p < .001.

Table 5

Preference Scores of Testing Techniques by Cognitive Style

Testing Technique	Cognitive Style: Concrete Sequential	Dual Sequential	Abstract Random	Dual Random
Structured Problem-Solving[a]				
M	3.50[1]	3.53[2]	2.96	2.25[12]
SD	1.36	0.92	0.80	1.00
n	15	18	13	18
Independent Originations[b]				
M	3.31[1]	3.02[2]	3.28[3]	4.26[123]
SD	0.82	1.04	0.66	0.75
n	15	17	13	18
Multiple Choice Tests				
M	3.80	3.72	3.62	3.17
SD	1.21	1.07	0.77	1.29
n	15	18	13	18
Matching Tests				
M	4.20	3.94	4.08	3.78
SD	0.77	0.87	0.76	1.17
n	15	18	13	18

(table continues)

Testing Technique	Cognitive Style: Concrete Sequential	Dual Sequential	Abstract Random	Dual Random
Short Answer Tests				
M	3.87	3.94	4.00	3.61
SD	0.99	0.64	0.82	1.09
n	15	18	13	18
Fill-in-the-Blanks				
M	3.60	3.22	3.46	3.39
SD	0.74	1.11	0.88	0.92
n	15	18	13	18
Essay Tests				
M	3.80	3.94	3.92	4.00
SD	0.94	0.80	0.76	1.24
n	15	18	13	18
Problems w/ Multiple Solutions				
M	3.13	3.24	3.08	3.67
SD	1.36	1.15	1.04	1.50
n	15	17	13	18

Note. Matching superscripts indicate means which are significantly different at the $p < .05$ level within each testing technique row.

[a]Structured Problem-Solving includes word problems and problems with concrete answers (i.e. math problems).

[b]Independent Originations includes performances or projects, oral presentations, and classroom discussions.

Table 6

Crosstabulation of Predominant Cognitive Styles by Major

Cognitive Style	n	Major: Science	Major: Social Science	Major: Humanities
Concrete Sequential	Act	9	5	1
	Exp	5.2	5.2	4.7
Dual Sequential	Act	10	6	2
	Exp	6.2	6.2	5.6
Abstract Random	Act	0	8	5
	Exp	4.5	4.5	4.1
Dual Random	Act	3	3	12
	Exp	6.2	6.2	5.6

Note. $^{2}(6) = 28.45$, $p = .0001$.

Act = actual value. Exp = expected value.